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(54) Eyeglass lens rim processing machine

(57) Eyeglass lens rim processing machine with an eyeglass lens holder for the holding of a lens blank, which is held on at least one side, and a processing device for the complete shaping of the lens blank by means of a crosscut, for the introduction of a top facet or a circumferential groove, or of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, as well as, if and as necessary, for polishing of the processed surfaces.

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## Description

The invention concerns an eyeglass lens rim processing machine with an eyeglass lens holder for the holding of a lens blank, which is held on at least one side, and a processing device for the complete shaping of the lens blank by means of a crosscut, for the introduction of a top facet or a circumferential groove, or of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, as well as, if and as necessary, for polishing of the processed surfaces.

German Patent 38 04 133 describes a process and a device for the shaping of an eyeglass lens, which is described as starting from a lens blank, in which the area between the perimeter of the lens blank and the perimeter of the shaped eyeglass lens is removed in the following manner: with the help of a separating tool, a crosscut is made, first radially to the perimeter of the rotating lens blank relative to the perimeter of the finished lens, and then along or parallel to this perimeter, and finally again radially to the perimeter of the lens blank, whereby the eyeglass lens, held between two half-shafts, is provided with a plurality of radial crosscut sections at intervals from each other, with a circumferential crosscut section between every two radial crosscut sections, at an angular distance from the crosscut section, and a regrinding operation is performed on the entire perimeter of the cut-out lens during the production of the respective crosscut sections. The radial crosscut and circumferential crosscut sections can thereby be performed by means of a laser beam, whereas the regrinding on the entire perimeter of the cut-out lens is performed by means of a conventional grinding disk, with a relatively large diameter, axially parallel to the axis of the lens blank. This grinding disk, being intended to remove only relatively small amounts of material, is in the form of a facet grinding disk. Accordingly, in this process known from prior art, a device for the implementation of the radial and circumferential crosscuts is necessary, as is a facet grinding disk of the conventional type. The eyeglass lens rim processing machine which operates according to this process is accordingly equivalent to a conventional eyeglass lens rim processing machine with only one facet grinding disk, which additionally requires a device for the implementation of the radial and circumferential crosscuts.

This process has the advantage that it is not necessary to machine the entire, unnecessary part of the lens blank during the shaping process, because, in the implementation of the radial and circumferential crosscuts, rather large shards of glass are removed from the lens blank.

In another eyeglass rim processing machine, described in German Patent 43 0 8 800, by the same applicant, the shaping of the lens blank, which is held between two coaxial half shafts and rotated, is performed by means of a preliminary and final grinding disk, for the grinding of the eyeglass lens contour, and with a groove for the grinding of a top facet, which is arranged axially parallel to the half shafts and can be moved radially and axially, relative thereto. A processing tool is attached to a bearing for a driven shaft of the preliminary and final grinding disk and serves for the production of a groove around the perimeter of the eyeglass lens and/or for the chamfering of the edges of the eyeglass lens perimeter. Also present in this eyeglass lens rim processing machine, known from prior art, is an additional tool which serves exclusively for the production of a groove around the eyeglass lens perimeter or for the chamfering of the eyeglass lens perimeter edges. This additional tool can consist of a milling or grinding tool arranged with its axis of rotation radial to the eyeglass lens and driven by its own drive motor at a high rpm rate.

Relative to this eyeglass lens rim processing machine, known from prior art, the invention is based on the problem of avoiding the disadvantages of such a machine and improving it in such a way that all necessary working processes can be performed on an eyeglass lens with little effort, whereby the machine should be made smaller and its noise level should be reduced.

On the basis of this problem, an eyeglass lens rim processing machine is hereby proposed which, according to the invention, shows an eyeglass lens holder for the holding of a lens blank, which is held on at least one side, and a processing device for the complete shaping of the lens blank by means of a crosscut, for the introduction of a top facet or a circumferential groove, or of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, as well as, if and as necessary, for polishing and/or chamfering of the processed surfaces.

The invention is based on the consideration that a combination of additional tools and conventional grinding disk space not offer the possibility of reducing the size of the eyeglass lens rim processing machine, preventing a high noise level therein, or shortening the processing time of the lens blank to the point of completion of the finished eyeglass lens. On the other hand, the processing device according to the invention accomplishes a complete shaping of the lens blank by means of one crosscut, so that regrinding by means of a conventional grinding disk for the final shaping and for the introduction of a top facet or a circumferential groove is no longer required. This processing device is also capable of introducing a top facet, or grooves for the fastening of an eyeglass frame by means of clamps, or drilling holes, as well as polishing the processed surfaces.

Preferably, a CNC control is provided for the course of the required relative movements between the processing device and the eyeglass lens, in order to enable the automatic performance of the complete shaping, with a high degree of accuracy and without any great requirement for skill on the part of the operator. This CNC control can also serve to modify the feed rate in the course of the processing, according to the perimeter contour of the eyeglass lens selected as a function of the momentary radius and/or the eyeglass lens thickness. In this way, the feed rate will be reduced when the radius and/or the lens thickness is large and increased when the radius and/or the lens thickness is small.

The processing tool or tools in the processing device can have a variety of forms. For example, the crosscut, the introduction of a crown facet or of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, can be performed by means of a laser beam. On the other hand, a mechanically operated tool is more suitable for the production of a circumferential groove.

Preferably, the processing tools used will consist of milling tools running at a high rpm rate or suitably shaped grinding tools, whose drive system can consist of an air turbine, a water turbine, a combined air and water turbine or a high-frequency electric motor, whereby it is possible to provide the processing device with a tool for complete shaping, parallel to the lens blank axis, and at least one additional tool for the performance of the additional processing stages.

In an especially preferred manner, the processing device, however, will show only one tool for the performance of all processing stages.

An especially advantageous embodiment of the invention involves the placement of an end mill or a suitably shaped grinding tool, with a drive system operating at a high rpm rate, on a

carrier, so that said end mill or grinding tool is radially and axially displaceable relative to the lens blank axis and capable of angle adjustment. When the holder for the lens blank is made in the form of a rotatable shaft and the end mill or suitably shaped grinding tool, with its drive system, can be adjusted at various angles between a position axially parallel to the lens blank and a position perpendicular to the lens blank, all of the processing steps can be rapidly performed, with little effort, by a single tool.

Because a high-speed drive motor – whether in the form of an air turbine, a water turbine, a combined air and water turbine or a high-frequency electric motor – takes up only a very small volume and the processing forces exerted on the workpiece are low, only small clamping forces are required for the lens blank. Accordingly, it can be sufficient to hold one side of the lens blank against a suction cup on the holding shaft by means of a vacuum, whereby the effort and expense involved in the construction of the eyeglass lens rim processing machine, as well as the space taken up by such a machine, can be considerably reduced. Processing tools running at a high rpm rate show a low noise level during processing; moreover, thanks to their small dimensions, can be conveniently packaged.

In the selected embodiment, with only one processing tool in the form of an end mill or a suitably shaped grinding tool, the processing tool for the shaping of the lens blank is in the show a placed parallel to the axis of rotation of the lens blank and, in accordance with the shape entered into the CNC control for the eyeglass lens to be manufactured, moves radially, relative to the axis of rotation of the lens blank, and then axially, in order to follow the spatial curve of the eyeglass lens to be processed. Subsequently, the carrier for the processing tool is rotated out of the axially parallel position into a radially directed position, for the introduction of a top facet or a circumferential groove, or of grooves for the fastening of an eyeglass frame by means of clamps.

If drilling holes are required in the shaped eyeglass lens, the processing tool can also be used as a drill.

According to another embodiment, the processing tool can be in the form of a combined processing tool and exhibits one, basically cylindrical, area for the complete shaping of the lens blank by means of a crosscut, for the introduction of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes. Additionally and axially displaced thereto, a coaxial apex part is provided for the introduction of a top facet, as well as an additional, similarly axially displaced, disk-shaped part for the introduction of a circumferential groove. This combined processing tool, with its drive system, arranged on a carrier, needs to be radially and axially displaceable relative to the lens blank axis, but does not need to be capable of angle adjustment.

Preferably, the drive system for the milling tool or grinding tool runs at an rpm rate of 60,000 to 360,000  $\text{min}^{-1}$ , so that the processing noise lies in the inaudible ultrasonic range.

The invention is described in greater detail below, by means of two embodiments shown in the drawing. The figures show:

Figure 1: a schematic top view of an eyeglass lens rim processing machine according to the invention, with a processing device axially parallel and radial to the lens blank and capable of angle adjustment.

Figure 2: a view of the lens blank during the shaping process.

Figure 3 and 4: the introduction of a top facet.

Figure 5: the introduction of a circumferential groove.

Figure 6: a combined processing tool on a carrier that is radially and axially movable but not capable of angle adjustment.

The figures show a schematic representation of a baseplate 1 of an eyeglass lens rim processing machine, with a bearing block 2 arranged thereon, for an eyeglass lens holding shaft 3 located within the bearing block 2. An essentially circular lens blank 13 is fastened, by means of a suction cup 4, to the eyeglass lens holding shaft 3. To this end, the eyeglass lens holding shaft 3 is hollow and connected, by means of an underpressure hose 15, to a vacuum pump 16.

Arranged on the baseplate 1 are guides 6 for a carriage 7, which can be moved along the guides 6 parallel to the axis 14 of the lens blank 13 and the eyeglass lens holding shaft 3. This carriage 7 is similarly provided with guides 8, which are arranged perpendicular to the guides 6. Moving along the guides 8 is a carriage 9, which holds a carrier 10 with a rotary drive system (not shown in detail) for a spindle 11 located therein. The carrier 10 is capable of angle adjustment around a vertical axis 29.

Arranged on the spindle 11 is an end mill or a suitably shaped grinding rod 12.

By means of a CNC control 17, which is connected to the rotary drive system for the eyeglass lens holding shaft 3, the displacement drive system (not shown) for the carriage 7, an additional displacement drive system (not shown) for the carriage 9, the angle adjustment drive system (not shown) for the carrier 10 and the vacuum pump 16, all of the movements of the processing tool 12 are controlled, for the shaping of the lens blank 13, for the introduction of a top facet 18, 20 or a circumferential groove 25 or for the introduction of grooves for the fastening of an eyeglass frame by means of clamps or of drilling holes in the eyeglass lens.

In order to perform the shaping of the lens blank 13 in the first processing stage, as can be seen from Figure 2, the end mill (in the case of a plastic lens) or the grinding rod 12 (in the case of a silicate lens) is first moved out of the position shown in Figure 1 against the perimeter of the lens blank and radially in the direction of the lens blank axis 14, until the desired eyeglass lens contour is achieved. At this stage, the lens blank initially does not rotate, until the radial distance corresponding to the eyeglass lens 22 to be shaped has been attained. The lens blank 13 is now made to rotate slowly, so that a crosscut 23 is performed by the end mill or grinding rod 12 along the perimeter contour of the desired eyeglass lens 22 to be shaped. Approximately diametrically opposite the first radial crosscut, the end mill or grinding rod 12 is again moved radially outward, so that a shard 24 falls away. Subsequently, the end mill or grinding rod 12 is again brought back radially to the eyeglass lens contour and the crosscut along the desired perimeter contour is continued, so that, after one complete rotation of the lens blank 13, when the first radial crosscut is completed, an additional shard 24 falls away.

In order to introduce a top facet, the carriage 9 is moved radially outward and the carrier 10, as shown in Figure 3, is introduced into an angular position which corresponds to the angle of a first side 18 of the top facet. The carriage 9 with the carrier is now moved radially in a manner corresponding to the perimeter contour of the eyeglass lens 22 to be shaped, and the carriage 7 is moved axially in a manner corresponding to the perimeter contour of the first side 18 of the top facet, thereby forming a cylindrical area 19 on the perimeter of the eyeglass

lens 22 to be shaped, as well as the first part 18 of the top facet. In order to form the second side 20 of the top facet and the corresponding cylindrical area 21, the carriage 9 with the carrier 10 is brought into the position shown in Figure 4 and the processing is continued in an axial direction opposite to that described with reference to Figure 3.

In the position shown in Figures 3 and 4, the end mill or grinding rod 12 can also be used to chamfer the outer perimeter edge of the cylindrical areas 19, 21, in order to remove any sharp edges.

Figure 5 shows how a circumferential groove 25 can be produced in the shaped eyeglass lens 22, by means of the same end mill or grinding rod 12, in a position precisely perpendicular to the axis of rotation 14 of the lens blank.

All of the working stage is described above can also be performed by means of a combined processing tool, which is shown in Figure 6. This combined processing tool exhibits, on a spindle 11, a disk-shaped part 28 for the introduction of a circumferential groove according to Figure 5, an apex part 27 for the introduction of a top facet 18, 20, and a cylindrical area 26, which is shaped like the end mill or grinding rod 12 for the implementation of the crosscuts. The carrier 10 with the rotary drive system, in this case, does not need to be capable of angle adjustment, but only to be moved, by means of the carriage is 7 and 9, parallel and perpendicular to the lens blank 14.

In this embodiment, the control is made simpler, because the requirement for angle adjustment does not exist. On the other hand, the processing tool is more complicated and possibly less robust, because it must necessarily protrude over a rather large distance from the spindle 11.

By means of the CNC control 17, the feed rate can also be controlled as a function of the momentary radius of the perimeter contour of the eyeglass lens selected and/or the eyeglass lens thickness. In this way, the feed rate will be reduced when the radius and/or the lens thickness is large and increased when the radius and/or the lens thickness is small.

The invention also includes an embodiment (not shown) with one tool for the shaping of the lens blank by means of a crosscut, for the introduction of grooves for fastening an eyeglass frame by means of clamps, or of drilling holes, and with an additional tool for the introduction of a top facet or a circumferential groove, which can be arranged independently of each other on suitable guides and activated one after the other by the CNC control 17.

For the implementation of the crosscuts as well as for the production of grooves for fastening an eyeglass frame by means of clamps, or of drilling holes, or of a crown facet, a suitable laser beam can be used, while the top facets shown in Figures 3 and 4 and the circumferential groove shown in Figure 5 can be produced by mechanical processing, by means of an end mill or a grinding rod.

In the present invention, the use of a small-format processing device is important, as it enables the eyeglass lens rim processing machine to be easily packaged in a small construction and to generate only a low level of noise.

Preferably, the rotary drive system for processing tools 12, 26, 27, 28 consists of an air turbine, a water turbine, a combined air and water turbine or a high-frequency electric motor, operating at an rpm rate of 60,000 to 360,000  $\text{min}^{-1}$ , and, thanks to this high rpm rate, exert only small forces on the workpiece. Accordingly, very low clamping forces are required for

the workpiece, and the one-sided clamping by means of the suction cup 4, as shown in Figure 1, is made possible.

For the introduction of grooves for the fastening of an eyeglass frame by means of clamps, and of drilling holes, into the eyeglass lens. The position thereof must be entered into the CNC control 17. This can be done by entering coordinates by means of the keyboard on the control 17. An additional possibility for entry involves positioning a cursor, by means of a joystick or a computer mouse, in the desired position on a representation of the eyeglass lens on a computer monitor, followed by registration of the desired position. Similarly, a data record supplied by the eyeglass frame supplier, with the shape of the glass and the position of the drilling holes and/or grooves, can be loaded into the machine, whereby this data record can be read in by means of the diskette, an EPROM, a bar code or a magnetic strip.

For the shaping of the lens blank 13, it is also possible to move the processing tool along the desired eyeglass lens contour without requiring the rotation of the lens blank 13.



## Patent Claims

1. Eyeglass lens rim processing machine with
  - an eyeglass lens holder (3, 4) for the holding of a lens blank (13), which is held on at least one side, and
  - a processing device (10, 11, 12; 10, 11, 26, 27, 28) for the complete shaping of the lens blank (13) by means of a crosscut (23), for the introduction of a top facet (18, 20) or a circumferential groove (25), or of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, as well as, if and as necessary, for polishing and/or chamfering of the processed surfaces.
2. Eyeglass lens rim processing machine according to Claim 1, wherein a CNC control (17) is provided for the course of the required relative movements between the processing device (10, 11, 12; 10, 11, 26, 27, 28) and the lens blank (13) and for control of the feed rate as a function of the momentary radius and/or the eyeglass lens thickness.
3. Eyeglass lens rim processing machine according to Claim 1 or 2, wherein at least one processing tool (10, 11, 12; 10, 11, 26, 27, 28), in the form of a milling tool or grinding tool running at a high rpm rate, whose drive system consists of an air turbine, a water turbine, a combined air and water turbine or a high-frequency electric motor.
4. Eyeglass lens rim processing machine according to either of Claims 2 or 3, wherein the processing device exhibits one tool for complete shaping, parallel to the lens blank axis, and at least one additional tool for the performance of the additional processing stages.
5. Eyeglass lens rim processing machine according to any of Claims 1 to 3, wherein the processing device (10, 11, 12; 10, 11, 26, 27, 28) exhibits only one tool for the performance of all processing steps.
6. Eyeglass lens rim processing machine according to Claims 3 and 5, wherein an end mill or a suitably shaped grinding tool (12), with a drive system operating at a high rpm rate, is arranged on a carrier (10), so that said end mill or grinding tool is radially and axially displaceable relative to the lens blank axis (14) and capable of angle adjustment.
7. Eyeglass lens rim processing machine according to Claim 6, wherein the holder (3, 4) for the lens blank (13) is in the form of a rotatable shaft.
8. Eyeglass lens rim processing machine according to Claims 6 and 7, whereby the end mill or suitably shaped grinding tool (12), with its drive system, can be adjusted at various angles between a position axially parallel to the lens blank (14) and a position perpendicular to the lens blank (14).
9. Eyeglass lens rim processing machine according to Claims 3 and 5, wherein a combined processing tool is provided with one, basically cylindrical, area (26) for the complete shaping of the lens blank (13) by means of a crosscut (23), for the introduction of grooves for the fastening of an eyeglass frame by means of clamps, or of drilling holes, and an apex part (27) for the introduction of a top facet (18, 20), as well as a disk-shaped part (28) for the introduction of a circumferential groove (25), and whereby said combined processing tool, with its drive system, is arranged on a carrier (10) and radially and axially displaceable relative to the lens blank axis (14).

10. Eyeglass lens rim processing machine according to any of Claims 3 to 9, wherein the drive system for the milling tool or grinding tool runs at an rpm rate of 60,000 to 360,000  $\text{min}^{-1}$ .

Attached is 1 page of drawings